BAROMETER CALIBRATION GUIDELINES FOR SUTRON XPERT DCP SYSTEMS

Updated November 2008

Center for Operational Oceanographic Products and Services
National Ocean Service
National Oceanic and Atmospheric Administration

For New Barometer Installations

Here is a step by step guide for doing the calculations and deriving the new barometer offset using fictional station Joe's Pier as an example.

(1) The Primary Benchmark (PBM) at Joe's Pier is 7330 A 1978 and is 5.172 m above Station Datum (SD). This value is obtained from the Engineering Division (ED) and is listed in the station specific requirements of the annual Project Instructions. For new stations contact ED.

(2) Determine the barometer height above PBM. (Obtained from the level abstract and/or tape measurement; tape measurements should be made to the vertical center of the barometer and be accurate to three decimal places). The value at Joe's Pier was -0.957 m.

(3) Adding the values from step 1 and 2 gives the barometer height above SD:

(5.172 m) + (-0.957 m) = 4.215 m (Round to three decimal places)

(4) Mean Sea Level (MSL) above SD may be obtained from the Project Instructions or by contacting ED. For Joe's Pier that value is 1.292 m.

(5) Subtracting the step 4 value from the step 3 value provides the barometer height above MSL.

(4.215 m) - (1.292 m) = 2.923 m.

(6) The height correction for the barometer above MSL is derived by multiplying the step 5 value by 0.1214 mb/meter.

0.1214 mb/meter x 2.923 meter = 0.35 mb. (Round to two decimal places)

This correction value generally does not change unless the barometer elevation changes. Verify the barometer elevation every five years unless the barometer is relocated.

(7) The installed station barometer was reading 1027.14 mb at Joe's Pier and the barometer offset was set at 0 which is the factory default. For new barometer installations, or installations where the height correction has not been calculated or is not included in the barometer offset, compare the reading directly with the handheld barometer at the same elevation as the sensor.

(8) In this case, the portable calibration barometer reading was 1027.10 mb. The portable barometer shows the true value at the instrument height, provided it is calibrated correctly with the barometric standards at the Chesapeake Instrument Lab or Seattle Instrument Lab.

(9) Compare the portable barometer reading with the installed station barometer reading, making sure that the portable barometer and the station barometer are reading at the same horizontal elevation (i.e., hold the portable barometer at the same level as the station barometer). This is very important and failure to do so may result in the introduction of minor height errors.

Determine the difference between the portable barometer and the station barometer readings:

Difference = Portable Barometer Reading – Station Barometer Reading

For the initial installation of the barometers, which includes barometers that have been installed and for which we are performing an initial calibration, we are adjusting the barometer sensor to compensate for differences that may arise due to the characteristics of the individual DCP. Therefore a difference of +/- 5 mb is allowed. Remember anytime a new DCP is installed, or a new barometer is installed/replaced; the +/- 5 mb difference is allowable.

Return the barometer to the instrument lab if the difference exceeds this value so that it can be recalibrated in the shop environment. Otherwise use the barometer and compute the calibration portion of the correction as follows.

The Calibration Correction is calculated as the difference between the portable barometer reading and the station barometer. Let us determine the Calibration Correction now.

Portable Barometer Reading = 1027.1 mb
Station Barometer Reading = 1027.14 mb

Calibration Correction = 1027.1 mb - 1027.14 mb = -0.04 mb

(The Calibration Correction should be rounded to two decimal places).

(10) New Barometer Offset = Height Correction + Calibration Correction

Thus,

New Barometer Offset = 0.35 + (-0.04) = 0.3 (Rounded to one decimal place)

Store 0.3 as the new barometer offset for Joe's Pier during this year's annual inspection, so the barometer values recorded in the DCP are directly related to MSL. Record the calculations and barometer coefficient value rounded to two decimal places on the site report because these values will be needed next year for the barometer check.

Equation Summary for New Barometer Installations

BHSD = Barometer Height above Station Datum
SD = Station Datum
BHPBM = Barometer Height above Primary Benchmark
BHMSL = Barometer Height above Mean Sea Level
MSLSD = Mean Sea Level above Station Datum
HCMSL = Barometer Height Correction above Mean Sea Level
CC = Calibration Correction

$$BHSD = SD + BHPBM$$

$$BHMSL = BHSD + MSLSD$$

$$HCMSL = (0.1214\ mb/m) \times HCMSL$$

$$CC = \text{Portable Barometer Reading} - \text{Station Barometer Reading}$$

$$\text{New Barometer Offset} = \text{Raw Barometer Offset} + HCMSL + CC$$

For Existing Barometer Installations

Here is a step by step guide for doing the calculations and deriving the new barometer offset for stations that have the barometer installed and coefficient 2 stored correctly in the past, again using fictional station Joe's Pier as an example.

If the height correction was determined previously and it has been less than five years since the barometer height above Mean Sea Level (MSL) was determined, then go to step 7; if it has been five years or more since the barometer height above MSL was determined, or the barometer has been relocated, start with step 1 to compute the height correction,.

(1) The PBM at Joe's Pier is 7330 A 1978 and is 5.172 m above Station Datum (SD). This value is obtained from the Engineering Division (ED) and is listed in the station specific requirements of the annual Project Instructions. For new stations contact ED.

(2) Determine the barometer height above PBM. (Obtained from the level abstract and/or tape measurement; tape measurements should be made to the vertical center of the barometer and be accurate to three decimal places). The value at Joe's Pier was -0.957 m.

(3) Adding the values from step 1 and 2 gives the barometer height above SD:

(5.172 m) + (-0.957 m) = 4.215 m (Round to three decimal places)

(4) Mean Sea Level (MSL) above SD may be obtained from the Project Instructions or by contacting ED. For Joe's Pier that value is 1.292 m.

(5) Subtracting the step 4 value from the step 3 value provides the barometer height above MSL.

(4.215 m) - (1.292 m) = 2.923 m.

(6) The height correction for the barometer above MSL is derived by multiplying the step 5 value by 0.1214 mb/meter.

0.1214 mb/meter x 2.923 meter = 0.35 mb. (Round to two decimal places)

(7) Let's say the portable calibration barometer reading was 1027.10 mb at the same vertical elevation that the installed station barometer was located. The portable barometer shows the true value at the instrument height, provided it is calibrated correctly with one of the labs barometric pressure standards at the Chesapeake Instrument Lab or Seattle Instrument Lab. Since the station barometer is recording values at MSL, we need to compare the portable barometer and the station barometer at the same height. We can compare both at MSL level or at tide house level where the station barometer is located; the easier method is to compare at MSL.

The height correction which was computed last year and recorded on the site report must be added to the value displayed by the portable barometer **on paper** so that the value will be at the MSL level.

Note that this height correction value should be added on paper only and portable barometer should not be tampered with in the field once it is calibrated in the labs with the barometric pressure standard.

The height correction from the past year was 0.35 mb which should be listed on the appropriate Site report.

So the portable barometer would have read 1027.10 + 0.35 = 1027.45 mb at MSL

(8) Next, determine the difference between the portable barometer and the station barometer readings. This represents the calibration correction portion of the total correction.

Calibration Correction = portable barometer reading - station barometer reading

If this difference exceeds +/- 1 mb then the station barometer must be replaced and the old barometer must be sent to FOD shop to be recalibrated in the shop environment. If the difference is less than +/- 0.2 mb, no calibration correction is required, but sensor drifting check must be investigated as listed in step 9 below. If the difference exceeds 0.2 mb and is less than 1 mb, then this value represents the calibration correction to the barometer offset for this year, provided the difference meets the sensor drifting check as listed in step 9 below.

The Calibration Correction is calculated as the difference between the portable barometer reading and the station barometer. Let us determine the Calibration Correction now.

Portable Barometer Reading = 1027.45 mb
Station Barometer Reading = 1027.90 mb

Calibration Correction = 1027.45 mb - 1027.90 mb = -0.45 mb

(The Calibration Correction should be rounded to two decimal places).

Remember, since this value is more than 0.2 mb, we **do need to** add this value to the height correction offset to find the correct barometer offset. Also we need to check if the station barometer is drifting, and if so, by how much. This is done in the next step. If records are kept in the field folder (or site report) we will know the initial setting of the barometer offset. In most cases the initial factory default setting will be 0.

(9) New barometer offset = height correction + calibration correction (if applicable). The height correction is always positive whereas calibration correction needs to be added algebraically (i.e. with proper +/- sign)

The value for height correction will be as previously calculated, unless levels were run to the station barometer this year. If this is the case, use the new height correction in the calculation below.

Thus, the new barometer offset = 0.35 + (-0.45) = -0.1 (Rounded to one decimal place).

Now let us determine how much sensor (calibration) drift has occurred since the station barometer was installed.

Station barometer drift = New Barometer Offset - Original Barometer Offset

Thus, in this case, station barometer drift = (-0.1) - 0.3 = -0.4 mb

If this difference exceeds +/- 1 mb then the station barometer must be replaced and the old barometer must be sent to lab to be recalibrated in the shop environment.

If the sensor drift is less than 1 mb, then continue with the next step.

(10) Store -0.1 as New Barometer Offset for Joe's Pier during this year's AI so that values recorded in the DCP by the barometer are directly relative to MSL. Record the calculations and barometer coefficient value rounded to two decimal places on the site report because you will need that value for next year's barometer check.

Equation Summary for Existing Barometers

BHSD = Barometer Height above Station Datum
SD = Station Datum
BHPBM = Barometer Height above PBM
BHMSL = Barometer Height above MSL
MSLSD = MSL above Station Datum
HCMSL = Barometer Height Correction above MSL
CC = Calibration Correction

$$BHSD = SD + BHPBM$$

$$BHMSL = BHSD + MSLSD$$

$$HCMSL = (0.1214\ mb/m) \times HCMSL$$

$$CC = \text{Portable Barometer Reading} - \text{Station Barometer Reading}$$

$$\text{New Barometer Offset} = \text{Raw Barometer Offset} + HCMSL + CC$$

$$\text{Drifting of the station barometer} = \text{New Barometer Offset} - \text{Original Barometer Offset}$$